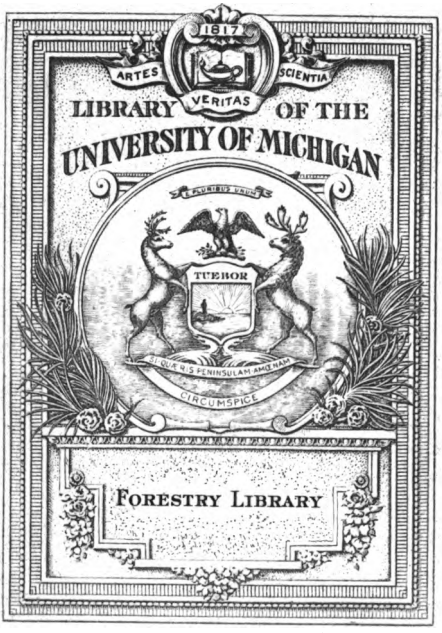
Chittenden, F. H. Some little-known insects affecting stored vegetable products.



BULLETIN No. 8—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

SOME LITTLE-KNOWN INSECTS AFFECTING STORED VEGETABLE PRODUCTS:

A COLLECTION OF ARTICLES DETAILING CERTAIN ORIGINAL OBSERVATIONS MADE UPON INSECTS OF THIS CLASS.

BY

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1897.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., January 21, 1897.

SIR: I transmit herewith the manuscript of Bulletin No. 8, new series, of this division. It consists of a collection of accounts of observations made by Mr. F. H. Chittenden in the progress of his work in the preparation of a complete report on insects affecting stored vegetable products, and its publication at this time is urged on account of the obvious desirability of an immediate record of the numerous important observations already made, as more fully explained in the preface.

Respectfully,

L. O. HOWARD,
Entomologist.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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PREFACE.

The World's Columbian Exposition, held in Chicago in 1893, served as the medium of importation of several species of insects of then imperfectly known distribution and habits, and incidentally much information was gathered from the collections made by the writer in the foreign agricultural exhibits that were displayed there. Similarly the Cotton States and International Exposition, held at Atlanta, Ga., in 1895, became the means by which knowledge of new food habits and habitat for a few species of doubtful or unknown habits and obscure origin has been gained. The material and other data obtained at the Columbian Exposition in stored products served as an impetus to the investigation of this group of insects and the living specimens in their food material obtained there, augmented by additions through correspondence and collections made in the city of Washington, have been under more or less continuous observation since. Certain of the preserved material has also received study, in connection with related forms, as time and opportunity afforded.

In the spring of 1894 the writer was directed to prepare a bulletin covering the subject of the insects affecting stored cereals. At the outset it was necessary, as a preliminary step, to properly identify the species to be considered. A number of radical changes have recently been made in the previously accepted nomenclature of these insects, involving the separation of species hitherto considered under a single name, the restoration to the species of the earliest published names, and the indication of synonyms.

Since its original inception the scope of the work has been enlarged to include insects affecting other stored products than cereals, and it has been thought advisable to compile as complete a bibliographical list of important references to each species as can be secured.

The preliminary labor involved in the preparation of such a work has consumed much time and is still in progress. It comprises the perusal of all available literature, including the indexing and digesting of numberless notes and articles, mostly scattered through periodicals and in many languages; the procuring of living specimens for rearing, and observation of the various species to be treated; the comparative study, description, and illustration of these species in all their various forms from egg to adult; the rearing and identification of parasites; the ascertainment of the character of the injury of the different species,

their range of food habit and other facts in their life history, and various other points of value and interest.

The records consulted show a present known total of between 150 and 200 species of insects that occur more or less frequently and normally in stored materials. About half of these species have been reared and observed at this office.

Certain of the more interesting and lesser-known forms have received mention in short articles and notes published in divisional bulletins and elsewhere, and the commoner species have been treated in a more popular manner in three articles, prepared, respectively, for the Yearbook of the Department of Agriculture for 1894, a Bulletin on Household Insects (Bull. No. 4, n. s.,) issued by this Division, and a Farmers' Bulletin recently published by the Department, making a total of eleven titles of publications having a bearing on this subject.

The completion of a more comprehensive bulletin is necessarily of so slow accomplishment that it has been thought desirable to bring together for publication a portion of the accumulated information on some of the more interesting new or little-known species. This matter is presented in the following ten articles, prepared in a somewhat more popular or less technical style than will be pursued in the more exhaustive work planned.

The different injurious species here considered are all amenable to similar treatment, and for the benefit of such as may not be fully informed upon this subject it should be stated that a consideration of methods of control, together with brief accounts of eighteen of the more important species affecting stored cereals, prepared by the writer by direction of the Assistant Secretary, has recently been issued as Farmers' Bulletin No. 45, by this Department, and may be had by application to the Secretary of Agriculture.

For convenience of publication it has been found necessary to group the accounts here given under a single comprehensive title. Hence it should be stated for bibliographical purposes that, although each account is not signed by the author, each should be indexed separately, as there is no connection between the different articles. Each is, to a certain extent, complete in itself, having no special bearing on either what precedes or follows it in the order given.

F. H. C.

SOME LITTLE-KNOWN INSECTS AFFECTING STORED VEGETABLE PRODUCTS.

A STOREHOUSE MOTH NEW TO THE UNITED STATES, WITH NOTES ON OTHER SPECIES.

The two or three years just passed are notable for the discovery of a number of new insect enemies to stored products of a vegetable origin to be added to the list of such species gathered by the writer at the Columbian Exposition and elsewhere and enumerated in the pages of Insect Life (Vol. VI, p. 219, etc.; VII, p. 326) and in other publications.

THE DRIED-CURRANT MOTH.

(*Ephestia cahiritella* Zell.)

Among other species obtained at both the Columbian and Cotton States expositions, and brought prominently to attention by the material collected at Atlanta, was one moth of the family Phycitidæ and genus Ephestia which manifested its presence by the work of its larva in nearly every exhibit of chocolate nuts or cacao beans. Moths were flying in numbers in a case of cacao exhibited by Jamaica at the Columbian Exposition, and a series of specimens of these and from Venezuela were secured. Specimens were also obtained from these two countries at the Atlanta Exposition.

It was obviously one of the species that are constantly being shipped to this country from abroad, but, as no food material for it other than cacao beans was known, it could not at first positively be said to be permanently located here, although such was surmised to be the case. The almost simultaneous discovery of the insect at Atlanta and in infested material from Ohio and the District of Columbia led to its study and identification.

The specimens bred did not correspond with anything in the National Museum, nor with descriptions of any species known to occur in this country. They agreed best with descriptions of *Ephestia cahiritella* and with the illustration of this species furnished in The Entomologist of 1890 (pl. 4, fig. 12), but not being quite satisfied with this tentative identification a series was sent to Mr. Edw. Meyrick, of Marlborough College, England, who has done special work in the Phycitidæ. From him word has been received to the effect that they are referable to

cahiritella, and that the specimens sent were more mixed with reddish than is usual.

This moth was first described by Zeller in 1867 from two examples from Cairo, Egypt, whence the specific name *cahiritella*. It was subsequently redescribed by Mr. C. G. Barrett, who called it *passulella* from its occurence in the so-called Corinthian raisins or currants ("*Passulæ corinthiacæ*"). To distinguish it from other species that infest dried fruits, it may be called after Barrett's Latin name, the dried-currant moth.

The moth looks suspiciously like *Ephestia kuehniella*, as also *elutella*, as will be noticed by reference to the illustration (fig. 1, *a*), being of a similar gray color, but may be readily distinguished from the former by the strong subdorsal line of the cilia of the hind-wings. The markings of the fore-wings are much more suffused than in the other two species and the line across the basal third is whitish, nearly straight, and bordered by a prominent dark, suffused band. In the others this line is irregularly dentate, or zigzag. The wing expanse is 14 to 20 mm.

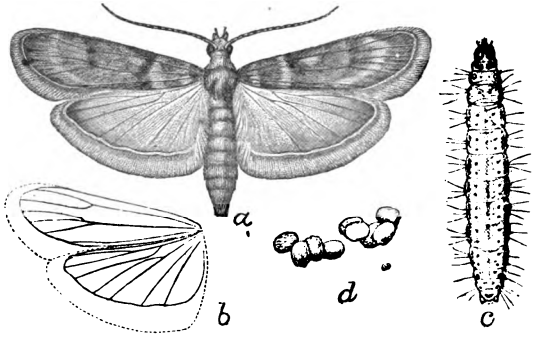

FIG. 1.—*Ephestia cahiritella: a*, adult moth; *b*, venation of wings; *c*, larva—enlarged about twice; *d*, eggs, more enlarged (original).

The larva, shown at *c*, also resembles that of the flour moth, exhibiting the same color variations, the ground hues ranging from dirty whitish to gray or yellowish, but with the flesh tints so arranged along the dorsum as to produce, with the piliferous warts which are larger and darker than in *kuehniella*, a distinctly striated appearance not seen in the latter species.

In October, 1895, a lot of flaxseed meal was received from Mr. H. G. Wolfgang, of Calla, Ohio, that was badly infested with the larva of this insect, and during the winter months English walnuts and figs obtained of various local merchants and street venders in different parts of the city were also found affected by it. During June, 1896, the chemist of the Department transmitted specimens of the larvæ in a sample of pearl hominy purchased in open market in this city. It contained two larvæ spun up in the same manner as is the custom with *Ephestia kuehniella*, the cocoon thus formed looking much like that of the flour moth. June 6 the first moth issued, and at about the same time larvæ were discovered at work in an open bottle of corn meal standing on my office desk. The meal had been used for observations on other insects and it had not been necessary to keep it covered. I then recollected having seen in this bottle of meal a moth of this species which had escaped

from an open box of nuts. Subsequently the moths were reared in great numbers, this accidental evidence of the cereal-feeding habit of the species proving more satisfactory than a purely artificial experiment would have done.

During July a larva, evidently from the same source as the ones found in the corn meal, was discovered at work in a small box of duplicate moths. It had ruined seven specimens by eating away their abdomens and in some cases a portion of the wings. In the rearing jars I had previously noticed evidences of this same habit.

It is yet early to predict the future of this moth. From its partiality for nuts and figs, taken with the fact that no cases of severe damage by it to cereals have come to light, it is reasonable to suppose that little apprehension need be felt of its becoming so serious a pest as the Mediterranean flour moth in flouring mills and granaries, in spite of appearances which indicate that it is perfectly capable of becoming troublesome.

THE CHOCOLATE MOTH.

(*Ephestia elutella* Hbn.)

The habits of our flour- and meal-feeding phycitids, *Ephestia kuehniella* and *Plodia interpunctella*, are so well known as to necessitate no further comment here, but there is still a fourth moth which, although represented in our faunal list, seems never to have received mention as an injurious species in this country. I refer to *Ephestia elutella* Hbn. Its habits have been known in Europe since early in the last century, yet so far as I know at present, American records show nothing positive regarding injuries.

Réaumur's account of the moth that injures chocolate, published in 1737, is generally conceded to refer to the present species, and as it is this species that is most often associated with the chocolate nut of commerce it may be called the chocolate moth. Recent study of bred material shows this to be the moth mentioned in Insect Life (Vol. IV, p. 332) as having been received at this office from Mr. H. F. Wickham, who found it injurious to cayenne pepper in one of the drug houses at Iowa City, Iowa. We have also specimens bred from dried apples obtained from a New York City dealer and submitted to this office by the Division of Chemistry, and others from cacao beans received from Mr. C. A. Barber, who obtained them from Montserrat, West Indies. According to various European authorities this species also attacks manufactured chocolate, coffee, and various dried fruits, and even does considerable damage to ship biscuit, which it injures after the manner of *E. kuehniella*.

STOREHOUSE MOTHS LIABLE TO INTRODUCTION.

In this same family Phycitidæ, as also in the Galleriidæ, are several other moths which, like the preceding species, are undoubtedly often brought into the United States in shipments of dried fruits and similar

merchandise. They are well known in England and elsewhere in Europe where they have been introduced, and they are liable to introduction into this country; if indeed, as seems probable, some of them are not already with us.

Ephestia ficulella Barr.—Of these species the present one may appropriately be mentioned first. It has not yet been placed on our lists, but there is a published record of its introduction with *cahiritella* at Lynn, England, in cotton cake shipped from Galveston Tex. (Ent. Mo. Mag., Vol. XX, p. 258). It receives its name from its depredations upon dried figs (Ficus) and is also partial to currants. This is the species mentioned on pages 141 and 350, Vol. V of Insect Life, as occurring in oatmeal at Kingston, Jamaica, *desuetella* Walk. being considered a somewhat doubtful synonym.

Ephestia calidella Gn. is another species of this genus that feeds on dried figs, raisins, and currants.

Ephestia (?) sp.—The larva of a phycitid resembling Ephestia, but differing from any known to me, was found by Mr. C. L. Marlatt, of this division, in pressed figs in this city, November 21, 1895, but unfortunately the adult moth could not be reared.

Certain other species of Ephestia, in addition to those mentioned above, have been described, and as they have been said to have similar habits, it may save trouble to state that of these *semirufa* Haw. and *roxburghii* Gregs. are now recognized as being synonymous with *elutella*, while *ficella* Dgl. and *xanthotricha* Staud. occupy the same relation toward *calidella*.

Myelois ceratoniæ Zell. is without much doubt the species taken at the Columbian Exposition in a box containing the seed pods of St. John's bread (*Ceratonia siliqua*) exhibited by the Spanish colonies. It derives its name from its habit of feeding upon this plant and is known also to attack dried dates.

A galleriid moth should be mentioned in this connection, viz, *Corcyra cephalonica* Stn., which occurs in fruit warehouses in Europe, living on dried currants.

NOTES ON GRAIN BEETLES OF THE GENUS SILVANUS.

Silvanus bicornis Er.

Our common saw-toothed grain beetle, *Silvanus surinamensis* Linn., was first described nearly a century and a half ago. Ninety years later, in 1848, W. F. Erichson separated it from another species which he described as *bicornis*. From that time till the present the validity of this species has been questioned. Without entering upon a discussion of the subject it may suffice to say that Erichson's *bicornis* has been, and perhaps still is, regarded by certain writers as the male of *surinamensis*. However that may be, M. F. Guillebeau considers it a good species (Revue d'Entomologie, Vol. IX, p. 221), and quite recently

we have obtained a specimen identified by Mr. Edm. Reitter as *bicornis* Er. Judging alone by this single example and the fact that I have examined fully three hundred individuals of Silvanus with saw-toothed thorax, brought together for the purpose, without finding anything even approaching it, I am much inclined to believe that this specimen is not a male of *surinamensis*, but whether or not it is the true *bicornis* of Erichson someone having access to the original description or the types may decide.

Judging by M. Guillebeau's description and our single specimen, *bicornis* differs from *surinamensis* chiefly by the side margins of the front in the male being more strongly reflexed, forming on each side a prominent horn, and by the scutellum being at least three times as wide as long and scarcely rounded behind. In *surinamensis* these reflexed portions of the front are of decidedly different appearance, and can hardly be termed horns. The scutellum is less than twice as wide as long and distinctly rounded behind. In the male before me the horns are very thin, much flattened, and concave dorsally, like the pointed ears of some mammals in outline, and distinctly incurved at the apex. (See fig. 2.) This male measures 3 mm., or about as long as the largest *surinamensis*.

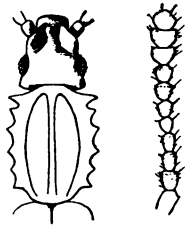

FIG. 2.—*Silvanus bicornis*—enlarged (original).

Erichson described his species from Tyrol and Sicily. Our specimen is from Kaifa, Syria. M. Guillebeau states that this species is extensively distributed in France, and that it was taken in wheat granaries at Orleans, and in a dried fig at Lyons, showing it to have similar feeding habits to *surinamensis*. It would naturally be called the two-horned grain beetle.

In more recent years several other species of Silvanus of the *surinamensis* group have been discovered.

The first of these is *denticollis*, described by Reitter in 1876, from Ceylon (Harold's Coleopterologische Hefte, Vol. XV, p. 56). It differs from all other known species of this group in having the head without tempora and the disc of the thorax without sulci.

In 1889 M. A. Fauvel described *mercator* from France, "Africa," and New Caledonia. (Revue d'Entomologie, Vol. VIII, p. 132.)

The following year M. Guillebeau brought together in synoptic form all the above-mentioned species, with *abeillei*, described as new from Palestine (l. c., Vol. IX, pp. 220–224) and later in the same year Reitter also furnished a synopsis of these species, describing *fauveli* from Syria. (Wiener Ent. Ztg., Vol. IX, pp. 255–256.)

SILVANUS MERCATOR Fauv.

When M. Fauvel described this species he remarked that it ought to be equally cosmopolitan with *surinamensis*, ergo, it ought to be found in North America. It remained unrecognized here, however, until the present year. At the Columbian Exposition I collected examples from Venezuela, Liberia, and Italy; from the Atlanta Exposition were obtained specimens from Venezuela, and quite recently the species was received in a lot of ground flaxseed from Calla, Ohio. There are in the National Museum collection specimens from Los Angeles, Cal., and from Astoria, Ill., and I have now living material from an unknown source, but taken at Washington, D. C. I have also seen specimens from Lower California and Arizona.

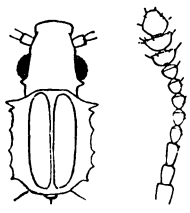

FIG. 3.—*Silvanus mercator:* head and thorax—enlarged; antenna at right—more enlarged (original).

The close relationship of *mercator* to our common saw-toothed grain beetle makes reasonably certain their virtual identity as regards development, nor is it probable that they differ in any degree in food habits. The former has been found in France, according to M. Guillebeau, in the débris of peanuts, in granaries of wheat, and under bark of sycamore in the vicinity of mills. In the writer's own experience it breeds also in almonds, English walnuts, corn meal and the fruit of the exotic plants *Myrospermum frutescens* and *Aleurites triloba*. The Illinois material was breeding in dried currants.

S. mercator differs from *surinamensis* chiefly by the much narrower tuberculiform tempora and in having the head and trochanters in the male unarmed. The accompanying illustration (fig. 3) will serve as a further means for its identification if compared with fig. 4.

To distinguish this species from related forms I suggest the name merchant grain beetle, the specific name being a translation of the Latin *mercator*.

FIG. 4.—*Silvanus surinamensis:* beetle—enlarged (author's illustration).

SILVANUS GOSSYPII n. sp.

The search for *bicornis* and *mercator* led to the discovery of a species not mentioned in Guillebeau's or Reitter's papers on this group, and so far as I can learn it is new to science. This resembles *surinamensis* superficially, though it is smaller and is conspicuous by the structure of the antennæ. The penultimate and the antepenultimate joints are nearly twice as wide as long, and in the three specimens in hand—probably males—the head, femora, and trochanters are unarmed. It is of similar color to other species of this group, its dense covering of long yellowish pubescence giving it a fulvous appearance. A technical description follows.

Silvanus gossypii n. sp.

General appearance of *surinamensis*, but smaller and slenderer, differing markedly in several particulars. Color of the head and prothorax chocolate brown, elytra cinnamon brown; entire surface opaque, densely covered with long yellow pubescence producing a fulvous appearance.

Head at least as wide as long, sometimes very slightly wider, narrowing anteriorly nearly as in *surinamensis;* side margins of front not prominent, very little reflexed; tempora of medium size, equal to one-third the diameter of the eye, conically prominent, somewhat variable, but with the lateral margin usually straight, rounded at the extreme apex. Eyes not prominent, but proportionately slightly larger than in *surinamensis*, of about the same width across as at the tempora, rather finely granulate.

Antennæ with well-defined club; first joint as in *surinamensis;* joints 2 to 8 strongly rounded; joints 2 and 3 not very much longer than wide; joints 3 and 4 nearly globular, 5, 6, and 7 just perceptibly wider than long. First and second joints of club broadly perfoliate, the first about one and three-fourths wider than long, nearly as wide as terminal one, the second widest, nearly twice as wide as long, terminal one about as wide as long, conically produced at apex.

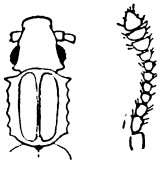

FIG. 5.—*Silvanus gossypii:* head and thorax—enlarged; antenna at right—more enlarged (original).

Prothorax comparatively feebly sexdentate; anterior teeth perceptibly but not conspicuously more prominent than the second pair, only moderately acute, sometimes rounded apically; basal teeth noticeably inconspicuous, not produced farther at the sides than the preceding pair. Dorsal sulci rather shallow, the median ones about one and one-half times wider than the lateral ones. Lateral carinæ subparallel, slightly arcuate at each end toward the median line.

Elytra nearly three and a half times as long as wide, subparallel, rounded posteriorly, comparatively finely but not deeply striate-punctate, intervals not noticeably prominent; ventral surface very finely pubescent, abdomen rather densely pubescent, otherwise nearly as in *surinamensis*. Scutellum very minute, obscure, but apparently more than twice as wide as long, and produced posteriorly at the middle. Femora only moderately robust, with no visible teeth; trochanters also mutic.

Length, 2.1 mm.; width, 0.5 mm.

Described from three individuals, of unknown sex, but probably males, received at the Department of Agriculture, Washington, D. C., in November, 1893, in cotton seed from India. Types in the United States National Museum.

The type specimens were all in perfect condition when found, which would appear to indicate that they were living when received at this Department.

This species is undoubtedly exotic, and probably not yet introduced in this country. From what we know of related forms it is fairly positive that it was breeding in the cotton seed, and that, like insects of related habits, it is capable of living upon cereal and other seeds in similar manner. It would perhaps be premature to place it in our list of species inhabiting America north of Mexico, although its title to be so listed is stronger than that of other species that might be mentioned. (See writer's remarks on *Calandra linearis et al.*, in Insect Life, Vol. VII, p. 332.)

GRANIVOROUS AND OTHER HABITS OF CERTAIN DERMESTIDÆ.

At the Springfield meeting of the Association of Economic Entomologists held in August of 1895, a paper by the writer on the herbivorous habits of certain Dermestidæ was read, but it being desirable to complete certain experiments that were then only begun, as well as to consult available literature on the subject, only a brief abstract of the original article was furnished for publication with the Proceedings of the Association (see Bull. No. 2, n. s., p. 36). The paper which is now presented includes such additional information as has been accumulated since.

The family Dermestidæ is so well known to all naturalists that the name has become almost a household word. Cyclopædias and text-books inform us that the members of this family feed upon dried animal substances. The depredations of certain species on leather, hides, and dried meats; of others on carpets, furs, and woollen goods; and of still others on dried insects, and other "objects of natural history" are, unfortunately, too well known to require further comment. Only occasionally do we find reference in American literature to damage to other than animal matter. The native *Byturus unicolor* and the European *B. tomentosus* are injurious to the buds and fruit of the raspberry and other Rosaceæ; *Dermestes vulpinus* is often, and *D. lardarius* occasionally, reported as injuring cork, wood, and even tobacco, but there is no reason to believe that the larvæ feed upon these substances, but merely burrow into them for pupation.[1] *Attagenus pellio* is known to feed on both animal and vegetable matter, the latter including dried plants in herbaria; *Anthrenus scrophulariæ* is said to have similar habits, and *Anthrenus varius* Fab. (= *verbasci* Linn.) has quite recently been charged with attacking a dried medicinal plant.[2]

More important, however, than any of these records is that cited by Mr. E. C. Cotes, of an East Indian dermestid, *Æthriostoma undulata* Motsch., the larva of which is averred to destroy 6 or 7 per cent of the wheat that is stored in go-downs in the Delhi market (Indian Museum Notes, 1894, Vol. III, p. 119, et seq.). This insect was first mentioned as a species of Trogoderma, and it is not improbable that it is the same that was exhibited by Mr. J. W. Douglas before the Entomological Society of London in 1860 (Trans., Vol. V, n. s., p. 113) as having damaged rice imported from Akyab, East India.

These are mostly foreign references. Until within very recent years I do not think it had ever been suspected that any of our several household dermestids would live in the larval condition upon vegetable substances.

[1] L'Herminier gives an account of damage to books by what he calls *Dermestes chinensis* (Ann. Soc. Ent. Fr., Vol. VI, p. 499), but the real author of the damage was not positively identified and might have been *Sitodrepa panicea* or an allied ptinid.

[2] To this list must be added *Trogoderma ornatum*, which I find since preparing this article has been observed by Prof. D. S. Kellicott eating grains of dry pop-corn (Proc. Columbus Hort. Soc., Vol. IX, p. 12, Apr., 1894).

Recent observations, however, prove that at least four common species have vegetarian proclivities. The species in question are *Attagenus piceus*, or black carpet beetle; *Trogoderma tarsale*, one of our worst cabinet pests; *Trogoderma sternale*, and our common *Anthrenus verbasci*.

The adults of certain of the Dermestidæ, it is true, are pollen feeders, but no significance attaches to this, as it is well known that the adult food habit of an insect is not necessarily an index to the habits of its larva. I need only mention among Coleoptera the families of the Carabidæ and Cleridæ, the larvæ of which are predaceous, and yĕt certain genera feed upon pollen in their adult condition. Certain of the wood-boring Scarabæidæ, Buprestidæ, and Cerambycidæ also are pollen-feeders as adults, while numerous instances could be cited among other families of Coleoptera where the adults eat pollen and the larvæ have totally different habits.

ATTAGENUS PICEUS Ol.

The larva of *Attagenus piceus* was received at this office September 20, 1894, in wheat and flour from a milling firm of central Indiana. In the same lot were several well known grain insects and it was thought at the time that the dermestid was merely attracted by the dead bodies of the purely grain feeders. In the following spring it was found in "middlings" in several mills and feed stores of this city, invariably with other insects and often with bits of sacking, feathers, and similar material.

I have in remembrance the finding of this and other dermestids in like situations, and many who read this can no doubt recall a similar experience, as well as that such occurences incited no further thought at the time than that in accordance with our accepted opinion of their habits they were feeding upon the dead insects or other animal matter that was almost invariably to be found in the immediate vicinity, if searched for.

Finally this insect was brought to my attention in such manner as to lead to the suspicion—despite traditional beliefs that the household Dermestidæ were strictly carnivorous and that the only appropriate habitat of this particular species were under carpets—that it might feed, at least occasionally, on vegetable substances. One lot of middlings contained a flour beetle that was desired for breeding, and to capture a sufficient number of these for the purpose little boxes of meal were placed with this material as traps. The desired beetles were entrapped in this way, but an equal number of Attagenus larvæ were also taken. Next an Attagenus larva and afterwards an adult were found that had been attracted to spillings of corn meal left overnight on my office table. I was now satisfied that the larvæ fed upon meal, but was it possible that the insect could actually breed in it?

The larva bred from the egg in flour and meal.—To settle the question, a few beetles were captured on the window-panes of the Department

building and confined June 12 in a bottle with a small quantity of flour and meal. In a week or so the larvæ could be seen at work through the glass. In five weeks they had reached the length of nearly a tenth of an inch, and August 20, or about ten weeks from the time of the eggs being laid, the larger individuals had grown to be two-tenths of an inch (5 mm.) long exclusive of the anal tuft, or over half the length of the full-grown larva. Four weeks later, September 21, they measured three-tenths inch (7.5 mm.). No perceptible increase in size, except a possible broadening toward the head, could be detected in the largest individuals October 30.

The dead bodies of the parent beetles, eight in number, were removed about five weeks from the time that they had been originally placed there. To my surprise, they had been scarcely injured—two had been decapitated and one had lost its abdomen—an evidence of a preference on the part of the larva for a farinaceous diet.

I have also numbers of more mature larvæ feeding on flour, meal, timothy seed, grain, etc.

During the summer of 1894 the writer obtained a number of samples of infested seeds and other products from the museum of this Department, in one of which, consisting of timothy seed, many larvæ of *Attagenus piceus* could plainly be seen. The seed was poured into a jar and with many others set aside for future observation. About a year later, when examined, the upper surface of this jar, which holds a little less than a gallon, was fairly covered with the cast skins of the larvæ. A few dead beetles were found and the peculiar cast skins of the last molt which remain about the anal extremity of the pupa could be counted by the score. The larvæ were in the greatest abundance near the surface, no less than thirty-two individuals being taken from a half pint of the surface layer and a few were found even at the bottom.

Too late in the season for experiment with a view to the discovery if the larvæ would breed *ab ovo* in the substances in which they occurred, living specimens were found in pumpkin seeds and in millet that had previously harbored the Indian-meal moth, and many cast larval skins in the herb sweet marjoram (*Origanum majorana*), which had also been infested with some lepidopteron.

Injury to bolting cloth.—While on the subject of herbivorous food habits of this species, I take occasion to add a few notes on a new habit and consequent new source of damage from it. During June of the present year word was received from a miller in Georgetown, D. C., that much trouble was being caused at his mill by an insect which injured his bolting cloth. This injury was attributed to *Tenebroides mauritanicus*, specimens of which were brought for determination. It was said that the insect cut the cloth even when the machinery was in operation, and that it had been at work for several years and caused more trouble than all the other insects in this mill. The miller was informed that the real author of the mischief was probably the larva of *Attagenus*

piceus, specimens of which were found, together with the adult Tenebroides, in the rolls of bolting cloth and crawling about on bags and sacking. To support this statement with facts, an experiment was conducted as follows:

A bit of perfect bolting cloth three inches square was placed in a jar of grain and meal containing about a dozen adult Tenebroides, covered with the grain and meal, and left there for seventeen days. At the end of that time the cloth was taken out with four Tenebroides beetles clinging to it, and although its meshes were partly closed by flour it was as sound as when placed in the jar. A similar piece of uninjured bolting cloth was put into a jar also containing flour and meal and about half as many half-grown larvæ of Attagenus, and in seventeen days, although only two larvæ were found upon it, it contained no less than twenty-eight small holes, one of them an eighth of an inch square.

Bolting cloth, as is well known, is the finest quality and most expensive silk fabric made, and the inroads of the Attagenus larvæ necessitate almost constant mending and replacement with new cloth. I have learned from at least three residents of this city that damage to bolting cloth of this nature has been noticed here and elsewhere for the past half century; also that this injury has been rather generally laid to the account of Tenebroides, which is known in some localities as the bolting-cloth beetle. Such a habit would be at variance with what is known of this insect, either as larva or beetle, and until positive proof is produced that it is the true culprit I can only conjecture as reason for the belief the fact that the Tenebroides is the commoner, the larger, and the more conspicuous insect.

Brief history of the species in America.—Looking back over the records, I find that this species was recognized in America as early as 1806, mentioned as abundant in houses in 1854, as injurious to feathers in 1866, to insect collections in 1878, and to carpets in 1879. As a carpet pest it attracts most attention, but has also been reported as injuring hair-cloth furniture, and has been accused of doing damage to lace curtains. I quite agree with Dr. Lintner, who remarks of this insect in this last connection (Second Rept. St. Ent. N. Y., 1885, p. 47): "If this suspicion is hereafter confirmed and its range of food found to embrace hair, furs, cotton, linen, and wool, then it is unquestionably a pest more to be dreaded in our homes than the rapacious and destructive carpet beetle," and particularly as flour and meal, seeds, and silk, not to mention feathers, leather, dried insects and probably many other preserved animal and vegetable substances are now to be added to its provision list.

This notice is by no means the only one of the occurrence of this species in cereals. In December, 1889, a correspondent at Craig, Mo., sent specimens of the larva which were found among the cocoons of *Plodia interpunctella* in corn in a flour mill (see Insect Life, Vol. II, p. 277). Dr. Hamilton, in his two lists of Coleoptera common to Europe

and North America, mentions its occurrence in granaries, and finally Mr. W. G. Johnson gives instances of its occurrence in warehouses in the American Miller for June and July of 1895. The latter reared the adults from nearly grown larvæ feeding on corn meal and from others living in flour. My present experiments of raising the insect from the egg places it beyond all doubt in the ranks of true grain-feeding species.

Dr. Lintner has surmised (l. c., p. 47) that this species is the author of reported injuries to cotton and linen goods. It is frequently noticed in mills, etc., on bags, but not having actual evidence that it attacks such cloth, the following experiment was made:

A bit of cotton was placed in a jar of flour in which the larvæ were feeding. The exact time of exposure was not noted, but when examined, October 30, it was found to be perforated here and there

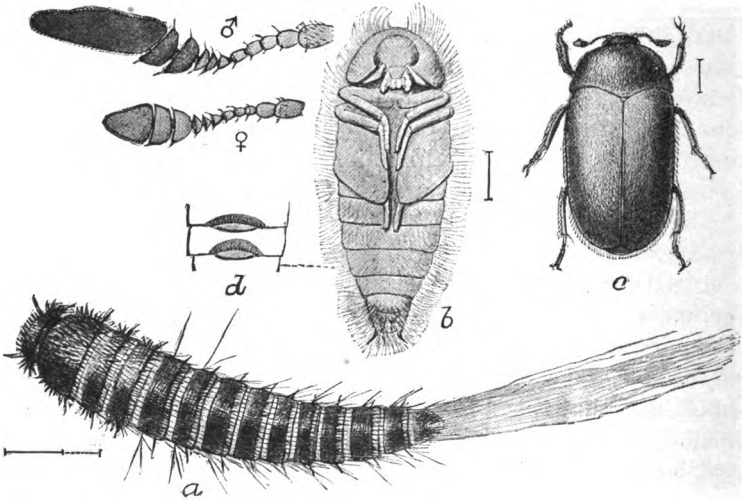

FIG. 6.—*Attagenus piceus*: *a*, larva; *b*, pupa; *c*, adult; *d*, dorsal abdominal segments of pupa; above at left, male and female antennæ—all enlarged (from Howard in Bull. 4, n. s.)

with holes of different sizes and so badly eroded that it tore on being subjected to the slightest force. It is more than probable that this larva is frequently the cause of considerable injury to flour and grain bags from its gnawing into and thus weakening them.

The species briefly described.—The beetle is of such common occurrence in the household in the spring and early summer time, particularly on our window sills, that little need be said of it at this time beyond calling attention to the accompanying illustration, which will serve for its identification. It is nearly black in color, with the ventral surface lighter and the legs and antennæ dark yellowish. It measures between two and three sixteenths of an inch in length (3–5 mm.). The sexes may readily be distinguished by examination of the antennæ, ♂ representing the male, ♀ the female, in the illustration.

The larva has been described, according to Rupertsberger, by both

Sturm and Loew. The former description I have not seen; the latter is evidently erroneously cited. The figure (6, *a*) shows its general appearance and the arrangement of its vestiture. The ground color is dark-reddish brown, the vestiture reddish. The dorsal surface is strongly convex and rather sparsely covered with short, coarse, somewhat scale-like hairs appressed to the surface and very sparsely interspersed with a few coarser erect hairs arranged in a transverse row on each segment. A tuft of longer hairs proceeds from each side of the head and the thoracic segments. The lateral hairs of the abdominal segments are longer, and arranged as in the figure, the anal segment terminating in a pencil of long, delicate hairs. The head is thickly covered with suberect reddish hair; the antennæ are four-jointed, and terminate in a seta. The ventral surface is whitish, and rather thickly covered with appressed reddish pubescence. The full-grown larva measures about 8 mm.

The pupa, figured at *b*, is white and delicate in structure, and covered with fine, light, fulvous, flocculent pubescence. It is larger than the adult, measuring about 5 mm. Each of six of the abdominal segments is provided with a short transverse curved plate, which faces a corresponding plate on the next segment, as shown at *d*.

TROGODERMA TARSALE Melsh.

One jar of flaxseed from the museum exhibit of the Department is infested chiefly by this common museum pest. Many of the larvæ may be seen through the glass, and large patches of their yellowish-brown gnawings and excrement show where they have been at work. In castor beans a few larvæ were present.

That these species of Trogoderma can subsist on a vegetable diet is as positive as it is surprising. No other Coleoptera to my knowedge live on oil seeds, and I had nearly arrived at the conclusion that as this form of matter was the nearest approach to animal food available, that these insects could only thrive on such vegetable substances as contain a considerable proportion of oleaginous matter. Judge of my astonishment, then, when a few weeks after the discovery of the Trogoderma living in oil seeds, Dr. Howard brought me a box nearly full of cayenne pepper in which were several Trogoderma larvæ. The most careful search failed to show even fragments of that well-known red-pepper pest, *Sitodrepa panicea*, or of any other insect than the dermestid. Subsequently the adult was reared and proved to be *Trogoderma tarsale*.

It seeming desirable to ascertain if this species would breed on so pungent a substance as cayenne pepper, a few adults were confined with a quantity of this condiment. In due time larvæ appeared, and when examined August 20, or nearly ten weeks from the time the eggs were deposited, were in vigorous condition, the average individual measuring a tenth of an inch in length, or about half that of the full-grown larva. Toward the end of September, while passing through the

museum of this Department, my attention was attracted by an accumulation of powder and dust about the edges of an exhibit of peanut oil cake, and another of Indian turnip bulbs. A great number of the larvæ and their cast skins were found under and on the under surface of the cakes; also in flour and meal prepared from peanuts. The Indian turnip bulbs were very old and dry, and might have been on exhibition twenty years or more.

When this insect infests a substance of similar color and consistency to flour or meal only a few larvæ are sufficient, on account of their extraordinary habit of frequently molting, to occasion alarm. In fact, appearances are much worse than the reality. Thus, in a small box of peanut meal in which these larvæ had taken up their abode, about forty larval skins had accumulated when examined September 27, completely covering one-half of the surface of the meal, and giving the impression of a whole colony of the insects.

After the experiences narrated I was prepared for almost anything, and was expecting that as this species was as nearly omnivorous as the preceding, it would in time be found like them to be granivorous. Having convinced myself by the process of "reasoning by analogy" that the insect *must* be a grain feeder, I had resolved to experiment with a view of ascertaining if the species would feed upon cereal food. A compulsory delay of a few days saved me the trouble. While the Division of Entomology was moving into new quarters a bag of "Saskatchewan fife" spring wheat, formerly kept in stock for gratuitous distribution, and described on the label as a hard, amber variety with an exceedingly heavy grain, was unearthed, in which the larva of this insect was living, there being present no other insects except a colony of Anthrenus and a single stray Silvanus.. In fact, this grain is so hard and flinty that weevils would not flourish on it.

Soon afterwards I found larvæ in another lot of wheat infested with Silvanus, and in corn containing *Calandra oryza* and other small beetles. About the same time, Mr. Frank Benton brought me larvæ found in beehives, where they apparently fed upon propolis, or bee glue. There are several recorded instances of *Dermestes lardarius* feeding upon wax,[1] or, more properly speaking, honeycomb, and it is therefore fairly certain that Trogoderma has the same habit, although not previously reported in beehives.

Among the divisional notes I find one recording the receipt of six larvæ of this species in a box of red pepper, from a correspondent in Utah, November 22, 1882. These larvæ were kept in the box of pepper for a year, at which time fifty-four cast larval skins were noticed. The box was examined January 14, 1887, or over four years from the time of its receipt, when two larvæ and seventy more cast skins were found, but no trace of beetles, although it had been kept closed, so that it was impossible for either larvæ or adults to escape. It is very obvious

[1] See Lintner's 6th Rept., pp. 122–123; Dubini (L'Ape e il suo Governo, 1881, p. 266).

that four larvæ, or the beetles that developed from them, had died in the interim and were then devoured by their fellows. In any case, the adult was not reared, and no published statement was made of the larva having been found living in the condiment.

The capability of this species to breed in other seeds was demonstrated by the discovery of the larvæ living upon "kolu," an edible leguminous seed somewhat resembling a cowpea. The insect had evidently been first attracted by the dead bodies of the original inhabitant of the seeds, the weevil, *Bruchus chinensis*, but had afterwards fed upon the seeds, even hollowing them out and leaving only the empty shells. In a similar manner, larvæ were found, together with those of Attagenus, in millet and pumpkin seeds that had formerly been inhabited by the polyphagous Indian-meal moth, *Plodia interpunctella*.[1]

TROGODERMA STERNALE Jayne.

Among the samples of infested seeds selected from the Department exhibits were several containing larvæ that were entirely unknown to me. They seemed to belong to the genus Trogoderma, but differed considerably from *T. tarsale*, with which in one or two jars they were associated.

The infested jars were kept in a moderately heated basement room and the first of April a few imagos made their appearance. At about the same time specimens of this same species were referred to this office for identification by the Division of Economic Ornithology and Mammalogy. Subsequent search discovered many individuals in all stages in jars of linseed, castor beans, silkworm cocoons, and red-clover seed. In the jar of cocoons, which were riddled with holes and utterly unfit for exhibition, this species was associated with *Trogoderma tarsale* and a few individuals of *Attagenus piceus*, and it is fairly certain that it was in these cocoons that the insects were originally introduced in the museum and that they had been there for several years.

Specimens reared here at Washington agree fairly well with certain color variations identified as *T. sternale* Jayne in the National Museum from New Mexico. This species was described in 1883 from material from New Mexico, California, Arizona, and Texas (see Proc. Am. Ent. Soc., Vol. XX, p. 363), and as Dr. G. H. Horn, to whom specimens were submitted for verification, concurs in the above opinion, we may consider the Washington material as belonging to this species. Its original habitat can scarcely be conjectured, but I surmise that it, as well as *T. tarsale* and other indoor species, is exotic and probably tropical. Its first published habitat tends to indicate that it might have been introduced through Mexico or Central America. The California locality from which Mr. Jayne had material was probably southern California,

[1] Since the preparation of this paper was completed Dr. John Hamilton has recorded the breeding of *Trogoderma tarsale* in packed figs (Canadian Entomologist, Vol. XXVIII, p. 262, Oct., 1896).

as we have specimens in the National Museum from there. Dr. Horn writes under date of December 5, 1895, that he has *sternale* "from all over the United States." It is evidently a comparatively new introduction in Washington, for had it occurred in any numbers in previous years it could not well have escaped recognition by the members of this Division on their visits to our museums.

Until my discovery of this species only *T. tarsale* had been noticed in any abundance in our agricultural museum, but judging from present experience it seems perfectly capable of holding its own with other cabinet pests, if, indeed, it does not supplant some of them.

The jars which were preserved represent samples from different glass columns, each of which contained several bushels of material. One jar of linseed contained both species of Trogoderma, but another was infested exclusively by the new species. The castor beans contained both species, but the clover seed only the new form.

Anthrenus verbasci Linn.

There are at least two published notices of this, another of our common insect cabinet pests, attacking vegetable substances—that already referred to, in Vol. VII of Insect Life, p. 32, wherein Mr. V. L. Kellogg remarks "attacking powdered cramp bark (*Viburnum prunifolium*)," and another earlier notice in Field and Forest (Vol. II, p. 184, 1877), by Mr. C. R. Dodge, of this Department. Shed skins of Anthrenus (species not stated, but undoubtedly *verbasci*) were found in an insect box in which "nearly all the labels had been deeply notched and eaten on all sides." Mr. Dodge was in doubt as to whether the insect had fed upon the paper from choice or from lack of other food.

Specimens of both larvæ and adults were received in the spring of 1895 from a lot of "middlings" in which were found Attagenus larvæ, but no significance was attached to this finding until a large number of the larvæ were discovered in spoiled flour from a local bakery.

The experience of the two writers above quoted indicates merely the ability of the larva to injure vegetal substances. August 6, it being unfortunately too late to rear the insect from the egg, a number of immature larvæ were collected in the damaged flour and transferred to a jar containing fresh flour that had been disinfected for the purpose. Here they at once made themselves at home, and in five weeks' time a notable increase in growth was observable. One of the smallest individuals, measuring when first isolated 1.8 mm., showed an increase of nearly double its length in this time.

During September many larvæ of this species were found together with *Trogoderma tarsale* living in peanuts and in meal, flour, and cakes prepared from them and from peanut oil. In the following month other larvæ were found in the same bag of hard seed wheat mentioned as harboring *T. tarsale*.

In February, 1896, I received from Mrs. E. C. Jones, Brooklyn, N. Y.,

a box of cayenne pepper infested with both the drug-store beetle (*Sitodrepa panicea*), which, as is well known, frequently lives in this condiment, and this Anthrenus. In April it was also found at this Department in different exhibits of red pepper, no other species being present. As we have previously recorded a similar occurrence of this Anthrenus in red pepper in which it was associated with an Ephestia (Insect Life, Vol. IV, p. 332), it is not presumptive to say that it, as well as Trogoderma, will feed upon this substance.

GENERAL CONCLUSIONS.

During the spring and summer of 1896 all the species mentioned in this paper have come to my notice again and again in farinaceous products, but sufficient has been said to establish these insects as herbivorous in their nature and I will forbear further mention of occurrences for the present. I have been somewhat particular as to details regarding the actual feeding habits of the different species, as it is a matter requiring caution. Had anyone told me two years ago that *Attagenus piceus* fed upon flour and meal, that *Trogoderma tarsale* reveled in fiery red pepper, and that another species could thrive on such laxative substances as castor beans and flaxseed I would have believed my informant guilty of romancing.

The change from a natural animal-feeding habit to a vegetable one must be attributed to altered environment. In the case of *Attagenus piceus* the insect might have been carried originally into granaries, barns, and mills upon hides and skins and upon bags and have been thus attracted by the dead bodies of Sitotroga, Calandra, and other grain insects, and when this preferred food became scarce the most available substitute, viz, flour and meal and the powdered grain resulting from the attacks of the grain feeders, was eaten. The presence of Anthrenus in flour may be explained in a similar manner, but not so the Trogoderma in oil seeds. There was positively no trace of other insects in the red pepper, in the castor beans, and flaxseed, and these attacks admit of no other explanation than that of an absence of more suitable food and show a wondrous adaptability to unnatural surroundings. Assuming that the carnivorous habit is the natural one, the herbivorous taste must have been gradually acquired and that many years ago.

A few words are due concerning the economic phase of the question. Let us first consider, for the sake of contrast, the life economy of a seriously injurious grain-feeding species, for example, *Ephestia kuehniella*. A single female deposits from 300 to 350 eggs, and in a climate as far north as our own there may be as many as six broods each year. The larva is practically restricted to flour and meal for subsistence. Every year we hear of the enormous losses occasioned through this insect's ravages. On the other hand the female dermestid is not known to be especially prolific; probably does not lay more than 50 or 60 eggs.

None of the species under consideration develop more than one brood each year; in fact, it is a common occurrence for them to extend their larval existence over a period of two or more years. They are omnivorous and appear to prefer an animal diet. There are no records of serious injury by them to other than animal substances.

Obviously there is little likelihood of any of these species of Dermestidæ ever assuming prime economic importance as enemies of cereal or other vegetable products, although each species in its own particular way inflicts its share of injury.

WEEVILS THAT AFFECT THE SEED OF THE COWPEA.

The cowpea is subject to the depredations of two species of weevils, *Bruchus quadrimaculatus* Fab. and *B. chinensis* Linn., which injure its seed in the same manner as the common bean weevil, *Bruchus obtectus*, does the bean. They begin work in the garden and field and continue to breed in the stored seed, which they very soon entirely spoil as food for man or stock, and seriously impair its germinating power. Both species are generally distributed and injurious in the South and are widening their range with the increasing use of their food plant.

Just when they were first introduced in this country does not appear to be known even approximately, nor do I find anything definite toward establishing the date of their first discovery here. In the old Melsheimer catalogue of 1806, *B. 4-maculatus* is mentioned, and in the younger Melsheimer's catalogue, published in 1853, both are listed as synonymous with *B. sinuatus* Sch., *chinensis* receiving mention as *scutellaris* Fab., by which name the species is generally known. In Dr. Horn's revision of the Bruchidæ, published twenty years later, both species are considered, this being the first definite record that I find of their occurrence in America, though undoubtedly they were introduced at an earlier date with their food plant.

ECONOMIC LITERATURE.

Until recent years little had been published concerning the habits of either species, the first notice of any extent being that by Dr. J. A. Lintner on *B. chinensis*, published in 1890 in his sixth New York report (pp. 127–129). Following this, three years later, "Pysche" (Vol. VI, pp. 447–449), and during the present year Messrs. Herbert Osborn and C. W. Mally of the Iowa Experiment Station, published a 9-page article on the same species in Bulletin No. 32 of that station (pp. 386–394).

Dr. Lintner did not work out the life history of *chinensis*, and his published surmise that its life history and habits "would be about the same as those of the common species," *B. pisorum*, is incorrect, as he has subsequently stated.

Mr. Slingerland presented some interesting facts concerning the development of *quadrimaculatus*, and Osborn and Mally gave an

account of its life cycle as observed in the seed room of the experiment station at Ames, Iowa, without, however, indicating the time of the observations or atmospheric conditions.

During the latter part of August of the past year specimens of these species were received for identification from Mr. A. L. Quaintance, of the Florida Experiment Station,[1] and during the autumn living material of both was found in this city.

The lateness of the season when living material was obtained and press of other work have prevented any extended comparative observations of these species, but experiments conducted at a former time upon *chinensis* throw new light on their development and enable an estimate of the number of generations annually produced. As there has always been considerable confusion in regard to the identity of these two species, and as both are of growing importance, economically, it has been thought well to introduce illustrations of each and to point out the specific differences.

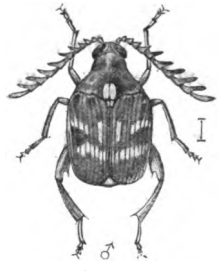

FIG. 7.—*Bruchus chinensis:* male—enlarged (original).

THE SPECIES COMPARED.

The two species of cowpea weevils resemble each other, after a manner, superficially, but there are excellent and very obvious characters for their separation.

Bruchus chinensis is the more robust species and it may be at once distinguished by the two large, elevated eburneous, or ivory-like, basal thoracic lobes, and strongly pectinate antennæ of the male. The ground color is dull red, sometimes more or less blackish, and is ornamented with yellow and gray or white pubescence. The pattern of the elytra varies considerably, that shown in the illustration (fig. 7) being the prevailing form of specimens bred in stored seed. The dark spots at the sides are not round and conspicuous as in *4-maculatus* and the apical spots are sometimes wanting, while often black is the prevailing color of the dorsal surface.

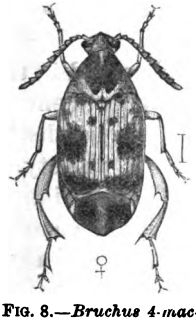

FIG. 8.—*Bruchus 4-maculatus:* female — enlarged (original).

Bruchus quadrimaculatus is the more slender species and differs from the preceding by the following characters: The ground color is black, with black, gray, and white pubescence. The antennæ are serrate and not pectinate in the male. The basal lobe of the thorax is marked with white pubescence only. The elytra are longer, and the gray and white pubescence is so arranged as to leave the four large black spots, whence the species derives its name. Two are in the middle of the elytra on the margin and two at the apices. These markings are variable and are

[1] The same gentleman has given, since the above was written, a brief account of both species in Bulletin No. 36, of the Florida station.

often lacking, even in fresh specimens. They also become almost entirely obliterated in old individuals. What appears to be the commonest form of coloration is illustrated (fig. 8). This represents a fresh female, the abdomen being large and protruding beyond the elytra.

It is not probable that these two species differ in any striking manner as regards their life habits and economy, but a careful comparison will undoubtedly bring out certain points of difference.

THE COWPEA WEEVIL.

The above name, which is proposed for *Bruchus chinensis*, will sufficiently distinguish it from *B. 4-maculatus*, since the latter is already known as the four-spotted bean weevil.

Divisional records of damage, etc.—In the columns of Insect Life reference has been made to this species, particularly with regard to the heat evolved by its action in cowpeas. Its occurrence was noticed in injurious abundance in cowpeas at Holly Springs, Miss.; in Chile, S. A.; in "peas" at Fredericksburg, Va.; in beans at the New Orleans Exposition, July, 1895; in Chinese beans at this Department, and at the World's Fair in 1893. In the last instance it was seen by the writer in the greatest numbers in cowpeas and "adsuki" beans, a variety of *Phaseolus radiatus*, exhibited respectively by Puerto Rico and Japan. In the Japanese exhibit it had ruined many large bags of seed. It was present also in cultivated legumes from Ceylon, known by the native names of "kolu" and "muneta."

September 10, 1896, Mr. A. M. Read brought to this office a lot of cowpeas of a black variety infested by this species. The seed had been purchased a year previously and was traced to a Baltimore wholesale house.

Toward the close of the same month this weevil was observed in the experimental plats of cowpeas on the grounds of the Department of Agriculture, and further search showed the exit holes of the beetles in the pods. These were most numerous upon the "Unknown" variety.

Distribution.—Previous to finding this insect breeding in the District of Columbia the writer had not thought it possible that it had accommodated itself to our climate, but had conceived the more conservative idea that all the northern occurrences were directly due to recent introductions of seed from the South. It would now appear that it is not a question as to whether the species is a permanent inhabitant of the District of Columbia and vicinity, but rather of how far northward of here it has gained foothold. The species has been known for sometime to be thoroughly acclimated throughout the Gulf States, and from present knowledge it is fairly certain that it is capable of establishing itself wherever its food plant will grow.

From foreign countries there are records of the occurrence of the species in Panama, Chile, the East Indies, Sierra Leone, Algeria, and Cape of Good Hope; and, of course, China.

Development of the insect.—The life history of this insect as observed by the writer in the District of Columbia is in brief as follows:

The eggs are deposited on the outside of the growing pods, to which they adhere tightly, and the larvæ hatch from them in four, five, or more days, depending upon the season and other circumstances, and burrow into the pods to the developing seed which they penetrate. In two or three weeks in midsummer weather the larva has attained full growth and now transforms to pupa. This state lasts from about four or five days in warm weather to considerable longer in cooler weather, when the beetle form is assumed. The beetle gnaws its way out of the seed in the same manner as do the other species of Bruchus by cutting a round flap through the skin of the pod. The first brood which develops in the field attains maturity at least by the third week of September, and perhaps earlier if we may judge by the appearance of the exit holes in the pods and the further fact that certain varieties of the cowpea mature earlier than the third week.

The beetles continue to develop in the dried and stored seed for several generations, in fact until the seed becomes completely ruined for any practical purpose and unfit even for the sustenance of this insect. In a very short time decomposition sets in inviting swarms of mites and the beetles are forced to other quarters in their struggle for existence.

Under ordinary circumstances six or seven broods probably develop anually in this latitude.

It is yet early to say with positiveness what varieties of seed are most subject to infestation by this insect. The "Unknown" cowpea seems to be the favorite variety in the Department plats; the seed of *Phaseolus radiatus* is quite to their liking, and they develop perfectly well in common peas and chick-peas (*Cicer arietinum*). The Ceylonese seeds in which they are found, and at present known to the writer only by their native names "kolu" and "muneta," were very small and the size of the beetles breeding in them was in proportion.

Natural enemies.—This weevil is attacked while in the immature condition by two or more chalcidid parasites of the subfamily Pteromalinæ; but the species have not yet been studied and need not be further mentioned now.

During the month of November an adult of this weevil that had very recently issued from a lot of cowpeas was found with many individuals of *Heteropus ventricosus* Newp., a common and omnivorous mite, attached to it.

THE FOUR-SPOTTED BEAN WEEVIL.

Divisional records of occurrences.—Our first experience with *Bruchus 4-maculatus* dates no farther back than in 1885, when this species was found at the first Atlanta Cotton Exposition infesting "black-eyed table beans" from Texas. At the World's Fair in 1893 it was observed by the writer breeding in great numbers in beans and cowpeas in the

exhibits of Brazil and Venezuela, most of the exhibited seeds being badly decomposed toward the latter days of the Exposition.

In May, 1894, we received specimens for identification from Mr. R. H. Price, of the Texas Agricultural Experiment Station, and later the species is mentioned in Bulletin 31 of that station (p. 466) as seeming to be the most injurious weevil to the cowpea in the State of Texas.

September 1 Mr. G. H. Hicks, of this Department, sent to this office at my request a lot of "Black-eye" cowpeas infested with this insect. They were obtained from the Georgia Experiment Station at Experiment in the spring of 1896. On the day following Mr. F. C. Pratt brought me two specimens of this insect which he had found in a package of soap just purchased at a grocery store in this city. At my request he repaired to the store for more material. In response to inquiry as to where the insects had probably bred the clerk stated that he did not know unless they had developed in a barrel of cucumber pickles, where they were abundant at the time. They were also conspicuously numerous in buckets of preserves, apparently being attracted by the moist sugar that had been used in preparing these. The beetles were also crawling all over the store, and the clerks were brushing them off as though they were fleas. Their origin was traced to a sack of cowpeas of the variety just mentioned. September 17, or fifteen days after the receipt of the infested cowpeas, they were again examined and found to be very musty and in an advanced state of decomposition, the odor being perceptible at a considerable distance. I have noticed of this species more than of any other insect that attacks stored products that decomposition sets in at a very early period, and that this is more noticeable in the case of cowpeas than any other product.

Distribution.—This species is well known throughout the South, and is in all probability to be found wherever cowpeas are cultivated. In the National Museum collection are specimens labeled Georgia, Florida, and Texas. We have series from Crescent City, Lake City, and Enterprise, Fla., and Mr. W. H. Ashmead has taken it at Utica, Miss. Messrs. Osborn and Mally found it breeding in the field at Ames, Iowa, and from frequently finding the species in the District of Columbia I have little doubt that it is acclimated here. From abroad we have specimens from Venezuela and Brazil, and the species is recorded also from the East Indies, Sierra Leone, and elsewhere.

Parasitic enemies.—From one of the lots of cowpeas obtained in this city were reared what appear to be three species of parasitic Pteromalinæ, all as yet undescribed and not referable beyond a certain doubt to the proper genera. In a peck of infested cowpeas obtained during November it was estimated that between 50 and 75 per cent of the seed taken from the top gave out parasites.

THE COMMON BEAN WEEVIL ON THE COWPEA.

During the autumn of 1896, I had frequent occasion to observe the beetles of the common bean weevil, *Bruchus obtectus* Say, upon the experimental plats of cowpeas on the grounds of the Department of Agriculture. They were evidently engaged in ovipositing on the plants, as specimens were reared later from the seed gathered from the field. In October Mr. Pratt found the insect at work in dried cowpeas that were on exhibition in the pods in the museum of the Department, which adjoins the experimental gardens.

It has been noticed of this species the past year that it begins to issue from beans in the field in the neighborhood of the District of Columbia as early as October, when in the natural course of events the eggs for a new brood would be deposited in such pods as had cracked open so as to expose the seeds within.

This species breeds in dried peas also, but whether it would attack this legume in the field where an abundance of beans were available as food remains to be seen.

It is not a little singular that the same or similar parasites that affect the cowpea weevils have never been reared from the common bean weevil.

DEVELOPMENT OF THE COMMON BEAN WEEVIL.

Our present knowledge of the early literature of *Bruchus obtectus* extends no farther back than the time of Say's description in July of 1831. The first economic account of the insect is credited to Asa Fitch, and appeared just 30 years later. Strangely enough it was not until 1870 that the species attracted any marked attention. In that year a number of accounts appeared, including a half dozen articles and notes published in volume II of the American Entomologist. Longer or shorter accounts have appeared in great number in succeeding years, but in only one that has been seen by the writer was any attention paid to the duration of the different stages of the species. In Insect Life (Vol. V, p. 86) Mr. M. V. Slingerland gave a brief statement of the development of the insect at Ithaca, N. Y., in dried beans, which may be summarized as follows: Egg, 12 to 20 days; larva, 24 to 42 days; pupa, 11 to 18 days; entire life cycle, 48 to 80 days; the first figure representing the period for warm weather, the higher number that for a colder period.

Having spent considerable time in earlier years at Ithaca, I am able to speak from experience of the great difference in the climate where these experiments were conducted and that of the District of Columbia. To obtain a proper conception of the difference it should be added that, in addition to the latitude and elevation of the two places, Cornell University, where Mr. Slingerland's experiments were made, is located upon a hill upward of 400 feet above the level of Cayuga

Lake, while the Department of Agriculture where the writer's experiments were made, is situated in the city of Washington, only about 40 feet above the Potomac.

Three experiments were conducted with a view to the determination of the rate of development of this species in dried beans, as follows:

April 30, twenty beetles were placed in a jar of disinfected dried beans, from which two adults issued June 18, or in 49 days (7 weeks).

The following day, June 19, a second experiment began with the confining of adult beetles with other beans. From this lot three imagos of the new brood developed July 16, or in 27 days.

The last experiment was undertaken in warm weather, and will denote approximately the minimum period of development in dried seed. Twenty imagos were placed with fresh beans June 19, and the first individuals issuing from these appeared July 10, or in 21 days (3 weeks).

We thus have ascertained definite periods in the life history of this insect under different atmospheric conditions, showing a variation of from 21 to 80 days.

It should be added that an experiment begun during an exceptionally heated period and conducted in a very hot room failed with this species, evidently on account of the excessive dryness of the seeds, although these had been partially decorticated for the purpose; also that the writer has evidence that the entire period from the laying of the egg to the issuance of the adult may be prolonged to three months or more in a sufficiently cold exposure.

Eggs that were laid April 30 hatched May 8, or in 8 days. Eggs laid October 27 hatched November 13, or in 17 days. Weather unseasonably warm; temperature of room, 60° to 70°.

The pupal stage in hot weather occupied 5 days, from July 16 to 21.

From experience with other allied species I do not believe that 8 days represents the minimum egg period. In the same weather and under the same conditions the egg and pupal periods for most Coleoptera that have come under my observation are nearly identical. Thus we have a minimum life cycle of 21 days, as follows: Egg, about 5 days; larval period, 11 days; pupal period, 5 days. This would give, with Mr. Slingerland's results, the following variations according to the atmospheric conditions, heat and cold, and possibly dryness and moisture:

Egg stage, 5 to 20 days; larval stage, 11 to 42 days; pupal stage, 5 to 18 days; entire life cycle, 21 to 80 days.

A LITTLE-KNOWN GRAIN WEEVIL.

(*Caulophilus latinasus* Say.)

Prominent among the insects collected at the Atlanta Exposition is a little cossonine weevil, indistinguishable from *Caulophilus latinasus* Say, found living in Indian corn and "Spanish peas" or chick-peas (*Cicer arietinum*) from Mexico. It was the only insect found in these particular exhibits of seeds, and its work appears to be not entirely unlike

that of the grain weevils, *Calandra granaria* and *oryza*, but it is at present impossible to speak of this with certitude, as the living material secured was limited, and for some reason did not survive the winter.

This appears to be the first instance of the occurrence of this insect in either stored cereals or legumes. There is, however, one record, by Mr. C. H. T. Townsend, of its having been found at Kingston, Jamaica, in a case of "scraped ginger" (Institute of Jamaica, Notes from the Museum, No. 78). Mr. Schwarz, in The Coleoptera of Florida (p. 468), says "rare, beaten from dead twigs;" and in volume I of Insect Life (p. 198) the species of Caulophilus are stated to have similar habits to other Cossonini, which live under bark and in decaying wood. Doubtless this was the original habit of the genus, and probably even at the present time it bores in dead roots and perhaps even in twigs.

The insect is slender and somewhat depressed, about an eighth of an inch in length, of a dark-brown color, and superficially resembling our native species of Phlœophagus and Pentarthrinus. Wollaston compares it to the European *Rhyncolus cylindrirostris* Oliv. (=*lignarius* Marsh.), but structurally it differs from these three genera. From Phlœophagus, with which it is most likely to be associated, the genus Caulophilus is said by Wollaston to be distinguished by its linear outline, depressed, deeply sculptured surface, and comparatively large eyes and scutellum (Insecta Maderensia, p. 315). Of the characters mentioned it differs from indigenous species of Phlœophagus only by the last two.

Since all the living material of this species perished, it is not yet positively proven that the insect actually breeds in grain, although such is with little doubt the case. However this may be, the published statements of the writer and others that only two species of weevils are injurious to stored grain in this country must now be modified in the light of the recent discovery by Mr. A. L. Quaintance of the anthribid weevil, *Brachytarsus alternatus* Say, breeding in stored corn, pease, and cowpeas (Ent. News, Vol. VII, p. 1, etc.). A near relative of the latter species, *B. variegatus* Say, has been discovered in stored wheat, but the injury was slight and apparently confined to the adults, as the species is a fungus-feeder, living in the smut of wheat and corn.

ON THE OCCURRENCE OF THE GRAIN MOTH (TINEA GRANELLA L.) IN AMERICA.

Tinea granella Linn., the wolf, or little grain moth, of Europe is of such rare occurrence on this continent that there are few if any authentic records of injuries by it, although in European countries it is classed with insects of the first rank in point of injuriousness. The word "authentic" is used for the reason that there are no preserved specimens of the moth, so far as can be learned, to substantiate published statements of either injuries or occurrence in cereals, and there are good grounds for the belief that some other species has been identified as *T. granella* more from the manner of its work than from the moth.

Another and much commoner insect, the Indian-meal moth (*Plodia interpunctella*) depredates upon grain in much the same manner as *T. granella*, and it is more than probable that a very considerable proportion of alleged cases of damage by *granella* are in reality due to the ravages of Plodia. Few collectors of insects have the patience and skill to properly mount specimens of these microlepidoptera, hence it might happen that even unspread moths of Plodia would be mistaken for *Tinea granella*. The larva and pupæ, though only superficially alike, cannot be distinguished except by rather close study or by comparison.

EARLY ACCOUNTS OF HARRIS AND FITCH.

The earliest account that can be found in American literature appears in Harris's Report on the Insects of Massachusetts Injurious to Vegetation, published in 1841. This is a compilation from European works, as appears from the concluding paragraph, in which this writer says: "The foregoing account will probably enable the readers of this essay to determine whether these destructive insects are found in our own country. From various statements, deficient, however, in exactness, that have appeared in some of our agricultural journals, I am led to think that this corn-moth, or an insect exactly like it in its habits, prevails in all parts of the country, and that it has generally been mistaken for the grain-weevil, which it far surpasses in its devastations. Many years ago I remember to have seen oats and shelled corn (maize) affected in the way above described, and have observed seed-corn hanging in the ears, to have been attacked by insects of this kind, the empty chrysalids of which remained sticking between the kernels; but, for some time past, no opportunity for further investigation has offered itself."

In the account of the Angoumois grain moth which immediately follows, and which is likewise compiled, it is perfectly plain that Harris was not at the time of this writing familiar with the work of either species.

Fitch gave some notes on *Tinea granella* in the Cultivator of January, 1847, which the writer has not been able to obtain, but Harris, in the Flint edition of Insects Injurious to Vegetation, remarks: "Dr. Asa Fitch has favored me with a grain-moth, obtained in a flour-mill at East Greenwich, N. Y., which agreed with the descriptions and figures of the European *Tinea granella*." If this last was truly *granella*, and this can be neither affirmed nor denied, it is somewhat singular that Fitch does not mention this species in his subsequent reports on "insects affecting grain crops."

GLOVER'S GRAIN MOTH.

Passing by the writings of Gaylord, Brinkle, and Emmons, in which mention is made of *T. granella* as unreliable, for the reason that these writings evince no evidence of original observation, we come to the

works of Townend Glover, who, in 1855, wrote of "the grain moth (*Tinea* ?)." This account was published in the Patent Office Report for 1854 (pp. 65–66), and was accompanied by plate illustrations of the insect in its several stages. In the following year (l. c. 1855, p. 99) the same writer has an account of "the corn-worm (*Heliothes* ?)," also illustrated and identified as the same species treated in the 1854 report. Later, in Manuscript Notes from my Journal or Entomological Index, which appeared in 1877, the same writer refers to this species as *Tinea granella*. The moth in question is described as occurring in the cornfields of the South, and as attacking corn in the husk "somewhat in the manner of the Angoumois moth." It is stated also that the larvæ "appear to attack corn out of the field as well as in," and that the insect lives in injured cotton bolls.

Through the kindness of Mr. E. A. Schwarz, who sent me from Texas specimens of the larvæ of this moth, both in cotton bolls and in corn from the field, I have been able to rear and identify the species. It proves to be *Batrachedra rileyi* Wals., which was described from specimens bred from cotton bolls, but it has not, so far as I am aware, been identified hitherto with the corn plant. This moth belongs to a different family of Tineina than either Sitotroga or Tinea, and it should be added that it does not in truth greatly resemble these moths either in appearance or in habits. It may be easily distinguished from these two genera by its narrower fore-wings, linear hind-wings, and annulated antennæ.

RECENT REPORTS OF TINEA GRANELLA.

In subsequent years Messrs. Packard, French, Fernald, and other entomologists mentioned *T. granella* among insects injurious to stored grain in this country, but without furnishing localities or original observations.

In the American Elevator and Grain Trade for March 15, 1896, Mr. W. G. Johnson states that he found this moth "in stored wheat from California, and on one occasion bred the adult from larvæ taken from a sack of corn meal purchased at a local grocery store at San Jose." At the present writing I have not seen specimens of the moth above reported, though Mr. Johnson has endeavored to procure them for me.

In response to a circular letter recently sent out by Dr. Howard to economic entomologists and others in regard to the distribution and injuriousness of certain noxious species of insects in the United States, word was received from seven station entomologists, representing as many States, that this species occurred in each of these several States.

On the occasion of a visit to the Capital by one of these gentlemen the writer found occasion to inquire as to the actual facts that had led to the reported occurrence of the insect in his State, pointing out by specimens the character of the work of *Plodia interpunctella*, with the result that our visitor frankly avowed that the species had been identified by the nature of its damage to the grain—that is, by the

webbed-up kernels, and that specimens of the moth itself were not at that time available. A second station entomologist of whom the writer made inquiry wrote substantially as follows: "I am afraid that this is one of those instances where a man speaks on traditional knowledge and without making any serious investigations. My case is, I fear, very similar to ———'s, because on looking up the matter I find that I have not a single specimen of anything that I would be willing to say is *Tinea granella*, while I do have the *Plodia interpunctella*. I have simply judged by what I have seen in the way of webbed-up grain and the numerous little moths that I have seen at times and have even occasionally captured and looked at with no very critical eye. In other words, I have absolutely no positive evidence of the occurrence of the insect in this State, but I do feel certain that there is a species different from the Plodia and differing also from the Angoumois moth which is found in granaries and barns in this State. I am very sorry that I can not help you to a decision in this matter; also that I should have been led to report the presence of the insect from a mere assumption. My only excuse is that no one has ever before questioned the occurrence of the insect in this country or doubted that the webbing of the grain which is so common was done in the main by this particular species of insect."

UNPUBLISHED RECORDS OF THE MOTH IN NORTH AMERICA.

In the record books of this Department and those of the late Dr. Riley are five entries referring to this species, but none are full and some are inaccessible at the present writing. These note references have been compared with specimens in the National Museum bearing the corresponding numbers, the result showing that all the biologic material except a single specimen recently unearthed in an unexpected place was reared from fungi. This specimen bears the following label: "Bred in flour barrel from S. Lockwood, Freehold, N. J." One series evidently correctly referred to *Tinea granella* is labeled: "On ergot from H. Osborn, Ames, Iowa, issued February 9, 1887." Mr. Osborn has recently written that these specimens were taken from exhibit samples in the agricultural museum of the Iowa State Agricultural College, and that "they were doubtless brought from a distance, possibly from abroad, and would not have any weight in regard to the species being established in the locality."

Two moths, indistinguishable from *granella*, were reared by Mr. Theo. Pergande from a rotten fungus growng on the Department grounds in Washington, D. C., and it should be added of this species that different European writers have recorded it as living in fungi and even in dried fruits.

SPECIES LIKELY TO BE CONFUSED WITH TINEA GRANELLA.

There are several other species of Tinea, that occasionally occur in storehouses or which from their habits and appearance are liable to be

mistaken for the European grain moth. Among these may be mentioned the following:

Tinea pallescentella Haw.—This European species has not yet been recorded so far as known from America, but is liable to introduction if not already established here, as it is known to feed in the larval condition upon dry refuse, being even said to attack grain.

Tinea fuscipunctella Haw. (?)—Either this or a closely related species was reared from a mass of material taken by Mr. F. C. Pratt at Lakeland, Md., from old barrels in a woodshed, in which turkeys had been kept, and containing refuse meal and other feed, hay, and the excrements of the fowls. European authors state that *fuscipunctella* lives in different sorts of dried material, which includes grass, the seeds of which it devours, and larvæ or pupæ from which the adults have been reared have been found in dust in cracks of the flooring of rooms, in the nests of the European chimney swallow, and in the hollow stems of parsnip (*Pastinaca sativa*) inhabited by *Depressaria heracliana*. The larvæ are supposed to feed upon the seeds of this plant.

Tinea spp.—One or two other species bred with the above in the meal and other refuse, but it is impossible to identify them at present.

Tinea (*Scardia*) *cloacella* Haw.—This species so closely resembles *granella* that it can only be separated from it by the closest scrutiny. In typical specimens the head is whitish ocherous and the fore-wings ocherous brown, while in the latter both head and fore-wings are whitish. It appears to be about equally common on both sides of the Atlantic, and to live exclusively on dry fungi.

Tinea sp.—A moth closely resembling *cloacella* in the ornamentation of its wings, but considerably darker than is usual in that species, was reared in abundance from a lot of pods of Yucca received in June, 1893, from Mexico. The moths issued from April 5 to June 30 of the following year:

Tinea defectella Zell.—This species somewhat resembles *granella* in markings, but the light portions of the fore-wings are white, or nearly so. We are indebted to Mr. T. D. A. Cockerell for a good series bred from *Polyporus rimosus*, a fungus parasitic on *Populus fremontii*, from Las Cruces, N. Mex.

CONCLUSIONS.

The question of the presence in America of *Tinea granella*, it must be conceded, rests upon rather insecure footing, not alone because of the scarcity of specimens and of reliable published records, but because in all likelihood such an injurious species as this is known to be would, if once introduced, make itself felt. Considering all the known facts in the case is it not probable that the cases cited of its occurrence here are the result of accidental and direct importation? Until the contrary can be proved it would appear safest to believe that this species is not permanently established in this country.

AN INVASION OF THE COFFEE-BEAN WEEVIL.

An interesting but probably not unusual case has recently come to light of infestation of a store at Washington, D. C., by a little weevil known as *Arœcerus*[1] *fasciculatus* DeG., and which from the specific name, *coffeæ*, by which it has until comparatively recent times been known, we may call the coffee-bean weevil.

December 16, 1895, there were received at this office living specimens of the beetle which had been taken from a lot of dried apples purchased at a local grocery, where they were reported in great numbers. The writer called at the store at which this purchase was made and learned that there had been an invasion of the insect in this store dating from midsummer.

Upon my pointing out the insect in the box of dried apples which they had evidently taken up as their permanent quarters the clerk promptly identified it as the same one that had been introduced in the store in an invoice of Java coffee stated to be of the finest quality and obtained of importers in New York City. The coffee was purchased

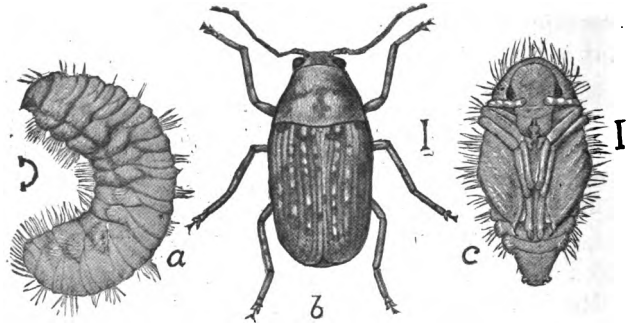

FIG. 9.—*Arœcerus fasciculatus*: *a*, larva; *b*, adult beetle; *c*, pupa—greatly enlarged (original).

in August, and soon afterwards the beetles were noticed poking their heads through the meshes of the coffee sacks and flying and crawling about the room. They were particularly abundant during September and were still present in sufficient numbers in the middle of December to be noticeable, although not so abundant or so active as to cause serious trouble. They were described as having been a constant source of annoyance in spite of the fact that they were, comparatively speaking, rather cleanly in appearance for an insect. They made their presence felt everywhere, getting into everything edible, into boxes of dried fruits and into crackers, showing a special fondness for fig cakes, and even, I was informed, intruding themselves in the refrigerator in search of food.

As no general account or good illustration of this insect in its several stages is available, the above figure, with a brief description of its

[1] Schönherr's original spelling of this generic name is *Arœcerus* (See Curc. Disp. Meth., p. 40; Gen. et Sp. Curc., 1833, vol. I, p. 173). In 1839 (l. c., vol. V, p. 273) it was changed to *Arœocerus*, and this latter spelling has been generally adopted.

appearance and a few facts concerning its history, habits, and distribution are furnished.

The adult beetle is shown in natural position at fig. 9. The form of the antennæ will sufficiently distinguish it from all other species likely to be found in similar locations. The head is prolonged into a short, broad, vertical rostrum, at the end of which are the mandibles. The ground color is dark brown, clothed with mottled light and dark brown pubescence. The arrangement of light and dark varies, but the illustration affords an idea of the average pattern. The length varies from two to three sixteenths of an inch (2.5 to 4.5 mm.). The insect has some resemblance to the Bruchidæ, with which family it was classed in earlier times, but is now placed in the family Anthribidæ which is given a position at the end of the rhynchophorous series by American systematists and an intermediate position between the Curculionidæ and Bruchidæ by European authors.

The beetle is a very active little creature, running, leaping, and flying readily when disturbed. From its occurrence in cotton bolls in the same situations as the cotton-boll weevil, *Anthonomus grandis*, it has been often mistaken for that species.

The larva exhibited at *a* is also mistaken for that of the boll weevil. It will be readily distinguished, however, by its more nearly uniform breadth, its proportionately larger head, and by other characters which will become apparent in comparing the accompanying figure (*a*) with that of the Anthonomus published in Insect Life (Vol. VII, p. 296), and in circulars Nos. 6 and 14 of this Division. The color of cotton-boll-bred larvæ and pupæ is salmon with honey-yellow head and dark brown mandibles, and the body is much wrinkled and hairy. The elytral pads in the pupa terminate in a peculiar unguiform process. The larva and pupa of *Anthonomus grandis* are whitish, and comparatively smooth and glabrous.

The species was first discovered upwards of a hundred years ago, but, I am informed, a popular account of the species from the pen of Sybilla Merian was published early in the last century.

Having been early distributed by commerce to all quarters of the globe, the insect is cosmopolitan and, as with other species of world-wide distribution, it has been described under various synonyms.

DeGeer's original description appeared in 1775, and in 1781 Fabricius described it, giving it the name of *Bruchus cacao*, from its food plant, *Theobroma cacao*, the nutritive seeds of which its larva inhabits. Fabricius afterwards described it under the name of *Anthribus coffeæ*, from another larval food plant, *Coffea arabica*, or coffee tree, the raw berry of which it also infests. It is reported as injurious to coffee in Brazil and to attack a species of ginger native to China. In our Southern States it is associated with the cotton plant, being frequently met with in diseased bolls and, since the prominence that has been given to the cotton-boll weevil, is often mistaken, as already stated, for that species.

Mr. Schwarz informs me that this insect also breeds in the seed pods

of the so-called coffee weed or senna, *Cassia occidentalis* and *C. obtusifolia*, and is particularly abundant in the seeds of a plant known in Florida as wild indigo, possibly either *Indigofera tinctoria* or *I. anil*, species formerly cultivated there and employed in the manufacture of indigo. It has also been received at this office in all its stages in a dry orange from Florida.

Living specimens were found by the writer at the Columbian Exposition in cacao beans from Liberia and in mace in the Trinidad and Johore exhibits. All of the jars containing the latter commodity had been attacked. There is also a record of this weevil having been "very destructive to nutmegs."

In addition to the localities above given it is recorded from Cape of Good Hope, Japan, Persia, New Holland, and the Sandwich Islands. The species is obviously tropical, and thought by M. Fauvel to have come originally from India.

The beetles often occur in our large commercial cities and seaports, but it is improbable that the species will ever become completely acclimatized (i. e., to an outdoor life) north of the cotton belt for lack of appropriate food. The experience of the past few months, however, have shown, somewhat to the writer's surprise, that the insect breeds rather freely in dried apples, so there is some slight danger of its finding a permanent footing in such storehouses as it may invade.

PARASITES OF FLOUR AND MEAL MOTHS.

The prominence that has been given to that scourge of the flouring mill, the Mediterranean flour moth, *Ephestia kuehniella* Zell., by its recent discovery in injurious abundance in mills in the States of New York and Pennsylvania, as first announced in the columns of the American Miller for May and December, 1895, and the fact that a new parasite has been found to prey upon this insect in California, renders it timely that certain memoranda concerning the known parasites of this destructive pest be brought together for record.

Parasites have also been reared from other moths occurring in flour and meal, and from what is known of their host relations it is fairly certain that they prey indiscriminately on moths of related habits, and some, and perhaps all, will in time be found to attack also the flour moth.

In the preparation of these notes I am indebted to Messrs. Ashmead and Coquillett for determinations of Hymenoptera and Diptera, respectively, and for other data.

PARASITES OF THE MEDITERRANEAN FLOUR MOTH.

Bracon (*Hadrobracon*) *hebetor* Say.—In Entomological News for December, 1895 (Vol. VI, p. 324), Mr. W. G. Johnson makes the first mention of the rearing of this species, together with another which Mr. Ashmead at present considers a variety of the same, from *Ephestia kuehniella* from San Francisco, Cal.

The value of one of the parasites of this moth as a counteractive against the overproduction of its destructive host is exemplified in the instance cited by Mr. Sydney T. Klein in the Transactions of the Entomological Society of London for 1887 (proc., p. liii) and referred to elsewhere, wherein it is related that a species which he states belonged to the Ichneumonidæ was instrumental in checking the ravages of the flour moth in London warehouses which it had invaded, and this when other means employed to dislodge it had failed. Just which species this might have been is not quite clear, but evidently either *Bracon brevicornis* or *Chremylus rubiginosus*, and presumably the former, as Mr. Archibald Giekie is quoted (Bull. Séances Soc. Ent. France, 1893, clxxviii) as having observed the complete destruction of the Ephestia by this parasite. This record is said to have been published, together with illustrations of both sexes of the parasite, in the County Middlesex "Natural and Sciences" Society of November 8, 1887.

February 14, 1893, Mr. Coquillett received from Mr. J. F. McIntyre, county commissioner of horticulture of Ventura County, Cal., specimens of *Ephestia kuehniella* with living braconid larvæ and their white silken cocoons found in beehives at Fillmore, that county. February 20 an Ephestia larva was received from the same source with a braconid larva attached to its body. January 8, 1895, we again received this species from the same source, in pieces of old honeycomb infested by the bee moth, *Galleria mellonella* Linn., the majority of the latter being parasitized by it. Two of the male parasites were noticed feeding upon the wax, and one of the females, after copulation, at once entered one of the cells near the caterpillars.

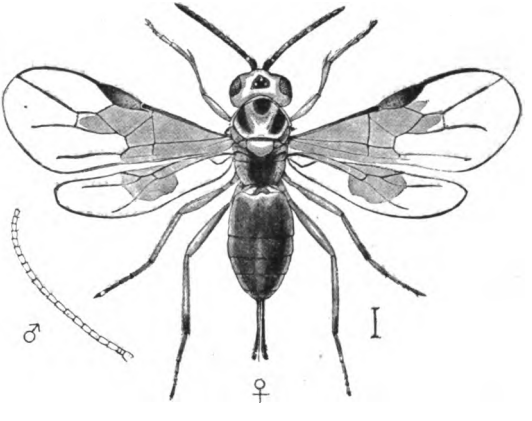

FIG. 10.—*Hadrobracon hebetor*: adult female—antenna of male at left—greatly enlarged (original).

November 24 a dead female was taken by the writer from a sort of receptacle that had been formed by its host in an English walnut (*Juglans regia*). The host caterpillar was dry and so badly shriveled as to be unrecognizable; but after boiling it and then subjecting it to the action of dilute acetic acid I was enabled to recognize it as the larva of a moth which I have identified as *Ephestia cahiritella* Zell. and which later bred from this same lot of nuts.

A month later we received a very full series of the insect from the Atlanta Exposition, where they were collected in jars of cacao beans from Maracaibo, Venezuela, and Trinidad, West Indies, infested with

both *Ephestia cahiritella* and the Indian-meal moth, *Plodia interpunctella* Hbn. In one lot of these beans the meal moth, recognized by its larva, was the only insect present. I had previously reared the parasite from grain infested with this moth.

In Volume VII of Insect Life we made mention of the rearing of this insect at Jamaica Plain, Mass., from the same host, but unfortunately the species was erroneously cited under the specific name *honestor* Say.

In 1888 Mr. Ashmead described in the Proceedings of the United States National Museum (Vol. XII, p. 621) a male braconid, to which he gave the name *Bracon juglandis*. It was reared by Mr. Albert Koebele from an unknown lepidopterous larva, referred to in Insect Life (Vol. II, p. 349) as doubtfully tineid, infesting old English walnuts at Los Angeles, Cal. This host caterpillar was probably either *Ephestia cahiritella* or *Plodia interpunctella*.

Mr. Ashmead informs me that this form, the dark one, is unquestionably the same species as *hebetor*, although it does not agree in colorational detail with Say's description. He believes that the marked varietal forms of this very variable species should be indicated, and therefore suggests the retention of the name *juglandis* as a variety.

Say described the female of *hebetor* with fourteen and the male with twenty-two-jointed antennæ. André gives *brevicornis*: ♀, 14–17 joints; ♂, 20–26 joints. In the series before me the joints vary from 14 to 15 and 20 to 22.

In comparatively small series of this species, even in what appears to be a single generation breeding out at the same time, a great individual variation in color is displayed. From the circumstances of rearing, aside from the lack of observable structural differences, I am convinced that this variation is not specific, the more so that this opinion is shared by Mr. Ashmead. The coloration varies from almost entirely honey-yellow to nearly black. A common type, as regards the arrangement of dark and light, is shown in the illustration (fig. 10).

Bracon brevicornis is recorded as having bred from the larvæ of *Ephestia kuehniella*, *E. elutella* and *Myelois ceratoniæ*, from *Dioryctria abietella*, and from the galls of *Andricus terminalis*. The hosts enumerated are not native and the parasite must necessarily be cosmopolitan, and it is not improbable that it may be the same as *Bracon brevicornis* Wesm., with the descriptions of which it substantially agrees. Say's description appeared in 1835, and therefore his name antedates Wesmael's, which followed three years later (Nouv. Mém. Acad. Brux., Vol. XI, 1838).

Chremylus rubiginosus Nees is mentioned in Insect Life (Vol. II, p. 260) as parasitic on *Ephestia kuehniella*. It has also been raised from the European grain moth, *Tinea granella* (Entom., Vol. XIV, p. 141), and is said by Curtis and others to frequently occur with the common European bean weevil, *Bruchus rufimanus*. *Bruchus seminarius* L. and *B. grandrius* Schh. and the clothes moth, *Tinea pellionella* L., are

also added as hosts by André (Spec. Hym. d'Eur., pt. iv, p. 254, 1888), and Motschulsky as long ago as 1853 (Études Entomologiques, 1853, p. 22) mentions *Hormius rubiginosus* Nees as a parasite of *Ernobius mollis* F., a ptinid now common to both continents and commonly found in old houses in the Old World. The species does not appear to have been recognized on this side of the Atlantic, but in Europe it is widely distributed.

Apanteles ephestiæ Baker was described in Entomological News, June, 1895 (Vol. VI, pp. 201–202), from specimens reared at Fort Collins, Colo., "from the larvæ of *Ephestia kuehniella* working in honeycomb, the flies emerging November 22."

PARASITES OF THE INDIAN-MEAL MOTH.

The two parasites of the Indian-meal moth (*Plodia interpunctella*) mentioned below should be added to those already alluded to as preying upon this and other allied species.

Omorga frumentaria Rond. was first reared from this moth in July, 1894, which was found breeding by Mr. Frank Benton in bran at Berwyn Heights, Md. Subsequently it was reared from the caterpillars of the same moth living on dried prunes in a local grocery, the imagos issuing from July 9 to September 20 and continuing to issue whenever the moths appeared. One jar of middlings that had contained large numbers of moths and their larvae in the fall of 1895 for some time produced nothing but parasites, and I had nearly arrived at the conclusion that the moth had been exterminated and the parasite had then died of starvation, but the latter only was true, as a few moths appeared toward the end of the following June. At the same time a number of these same parasites appeared in neighboring jars containing other moths, viz, *Ephestia cahiritella*. In one instance the parasite might have been brought in in English walnuts containing its host. In the other case the parasite must have thrust its eggs through the cloth covering of the jar, as it contained only fresh material put in in April and tightly covered.

The species was described by Rondani (Bull. Soc. Ent. Ital., Vol. IX, p. 169) in 1887 under the genus Campoplex from material reared from *Tinea granella* in Italy.

What is probably the first mention of a parasite of this moth is by B. D. Walsh in the Practical Entomologist of July, 1867 (Vol. II, p. 110). He says that "while in the larva state it is preyed upon to a very considerable extent by a small Ichneumon fly." This was probably either the above species or the Hadrobracon.

Limneria ephestiæ Ashm. has been recorded in Vol. III of Insect Life (p. 158) as also having bred from *Plodia interpunctella* "feeding on wax, Missouri, May, 1873," and from a noctuid pupa from Texas. It was first mentioned as *L. ephestiæ* Riley MS., but the species was not described until 1896 (Trans. Amer. Entom. Soc., Vol. XXIII, p. 195).

Apanteles carpatus Say.—This little braconid was reared in numbers from refuse hay, meal, and other feed infested with *Pyralis farinalis*, a large quantity of which was kindly brought me from Lakeland, Md., by Mr. F. C. Pratt, of this division. A cocoon of this moth was noticed that was unusually firmly attached to the jar, a sufficient quantity of silk being used to completely conceal the inclosed chrysalis. This chrysalis was found to have been perforated near the head, the hole corresponding in size to that of a parasitic larva of the species in question. The parasites began issuing in August, being present in the largest numbers at the time of the greatest abundance of their host, viz, during the hot weather toward the closing days of September and the 1st of October, and disappearing at the end of the latter month with the decrease of the moths. It reappeared in our rearing jars together with its host the following April.

Two other household hosts are known for this species: The clothes moths *Tinea pellionella* and *Trichophaga tapetiella* (*Tinea tapetzella*). The former was reared at Adrian, Mich., June 17, 1885, the latter at St. Louis, Mo., in July, as has already been recorded in Insect Life (Vol. III, p. 15)

Carcelia leucaniæ Kirkp.—From the same rubbish from which was obtained the preceding parasite two dipterous larvæ were taken August 17. One was placed in alcohol, the other in a jar of moistened earth, in which it immediately buried itself, the living imago appearing September 10. This is a common, well-known parasite of the army worm, *Leucania unipuncta*.

Clausicella tarsalis Coq., another tachinid described in the Journal of the New York Entomological Society of June, 1895 (Vol. III, p. 56), from Illinois, bred in upwards of a dozen individuals from the same material.

Unfortunately it can not be positively asserted that the two tachinid flies above mentioned are parasitic on *P. farinalis*, but such is probably the case, as the true genus Tachina is known to parasitize lepidopterous larvæ, and genera, nearly related to *Clausicella*, have the same habits.

Melanophora roralis V. d. W., a dexid, is mentioned by Brauer (Zweifluegler d. Kais. Mus. zu Wien, Vol. III, p. 76, 1883) as parasitic on this moth.

Spalangia rugosicollis Ashm.—A single individual of this rare chalcidid was also reared from the Pyralis-infested material, but as other species of this genus are known to infest Diptera it will most likely prove to be parasitic on one of the two tachinids occurring with it. This opinion is strengthened by the discovery with it of a puparium of about the same size as the Tachina, which shows an exit hole that corresponds well with what would be made by the hymenopteron.

Exochus mansuetor Grav.—This ichneumonid is mentioned as a parasite of *P. farinalis* in England by Rev. J. Hellins in his account of

the life history of its host (Ent. Mo. Mag., Vol. XXI, p. 249) and as having been obtained from the pupa of *Tinea fuscipunctella* Haw. by Dr. Fr. Loew (Verhdl. zool.-bot. Ver. Wien, Vol. XI, p. 393, 1861).

An ichneumonid was reared by the writer with *P. farinalis*, but the few bred specimens were unfortunately lost, and the species therefore remains unidentified. It is possible that it was the same above mentioned.

Perilitus ictericus Nees., a European braconid, is recorded by Rondani (Bull. d. Soc. Ent. Italiana, Vol. IV, p. 58) as a parasite of this moth.

The host moths with their parasites may be summarized as follows:

LIST OF HOSTS AND THEIR PARASITES.

Hosts.	*Parasites.*
Ephestia kuehniella *Zell.*	Hadrobracon hebetor *Say.*
	Syn. [?]: Bracon brevicornis *Nees.*
	Apanteles ephestiæ *Baker.*
	Chremylus rubiginosus *Nees.*
Ephestia elutella *Hbn*	Hadrobracon hebetor *Say.*
Ephestia cahiritella *Zell*	Hadrobracon hebetor *Say.*
	Omorga frumentaria *Rond.*
Plodia interpunctella *Hbn*	Hadrobracon hebetor *Say.*
	Omorga frumentaria *Rond.*
	Limneria ephestiæ *Ashm.*
Pyralis farinalis *Linn*	Apanteles carpatus *Say.*
	Perilitus ictericus *Nees.*
	Exochus mansuetor *Grav.*
	Unknown ichneumonid.
	Spalangia rugicollis *Ashm* (secondary).
	Melanophora roralis *V. d. W.* (Dip.).
	Clausicella tarsalis *Coq.* (Dip.).
	Carcelia leucaniæ *Kirkp.* (Dip.).
Tinea granella *Linn*	Chremylus rubiginosus *Nees.*
	Omorga frumentaria *Rond.*
	Hemiteles tineæ *Rond.*
Galleria mellonella *Linn*	Hadrobracon hebetor *Say.*

A FOREIGN PARASITE OF THE GRAIN WEEVILS.

At the present time only a single hymenopterous parasite is known to infest the grain weevils in the United States. This is the species described by Dr. Howard in the Annual Report of this Department for 1880 (p. 273) under the name *Pteromalus calandræ*. This species is now referred to the genus Meraporus, and as it is obviously an introduced cosmopolite, like its host, it may prove to be synonymous with some previously described species.

In Volume XII of the Entomologist for February, 1879 (p. 47), Mr. E. A. Fitch, in speaking of the parasites of the granary-inhabiting Calandras, says: "I have met with two (probably three) species of Chalcididæ, and Curtis knew another." Without at present entering into the subject as to what all these different species are, I will mention the one that Mr. Fitch probably had particularly in view.

November 10, 1896, a quart jar of Indian corn from Peru was transmitted to this office by direction of the Assistant Secretary of this Department, which upon examination proved to be infested primarily by the rice weevil (*Calandra oryza*). A parasitic hymenopteron of the family Chalcididæ was present in some abundance, somewhat outnumbering its host. Specimens were referred to Mr. W. H. Ashmead, who identified it as the species described and figured by Westwood in 1874 (Thesaurus Entomologicus Oxoniensis, p. 137, Pl. XXV, fig. 10) as *Chætospila elegans*. It is a member of the subfamily Spalangiinæ and some confusion exists as to the place that it may hold. Mr. Ashmead, however, is of the opinion that the genus Chætospila, of which this species is the type, must fall. According to Westwood, Chætospila differs from Cerocephala "in the short peduncle to the abdomen and the eight-jointed antennæ, these organs in Cerocephala being distinctly ten-jointed, the eighth and ninth being equal in size to the two preceding joints."

A reasonable excuse for this opinion is found in the fact that Westwood very evidently had at most not more than one or two specimens of but one sex (female) at the time of his description. Examination of a good series shows that the antennæ of the species are normally ten-jointed, although in some individuals it is difficult to distinguish more than eight joints. There are several well-defined joints and a club. In some individuals, of females as well as males, three segments in the club may be discerned under a good magnifying power; in some there appear to be but two; while in others there is hardly any visible evidence of segmentation or suture. Westwood, in this, as in so many other cases, evidently considered the club to consist of a single joint and so figured it.

The type or types were evidently all winged. The females of the present lot were winged, but the majority of the males are apterous and some have aborted wings.

For the benefit of those who may not be able to consult Westwood's work, it might be remarked that the body of this insect is shining dark brown, variegated with lighter brown, with green bronze and blue luster. The head is divided in front, so as to give the appearance of being three-horned. The fore-wings, in the female, reach to the end of the short ovipositor. Just beyond the middle is a nearly circular infuscated fascia and the optical moiety is fringed on the outer margin with fine hairs. The peculiar fascicles of short erect bristles at the junction of the subcostal vein with the costa, to which Westwood called especial attention as not being present to his knowledge in any other species, according to Mr. Ashmead, are at times also present in other species of Cerocephala. The length of this species is variable, but it does not often reach more than 1.5 mm. For further particulars the reader is referred to Mr. Ashmead's Synopsis of the Spalangiinæ (Proc. Ent. Soc. Wash., Vol. II, pp. 27–37).

Westwood does not designate either the host or the geographical habitat of this species, but from his description and colored illustration, together with the appended note on its occurrence, which is summed up in the legend "Habitat parasitice in Zeæ Maydis seminibus," it is reasonably certain that the specimens in hand are referable to the Westwood species. It is in all probability identical also with the species considered by Fitch (l. c.) to be either *Cerocephala formiciformis* Westw., "or a very closely allied species," bred from one or both of the grain-feeding Calandras in England. It is not the true *Theocolax formiciformis*, as I have been able to verify by comparing the Peruvian specimens with Westwood's figure, as well as with an example of the latter in the collection of Mr. Ashmead. The *formiciformis* was bred from "dead timber flooring infested with the larvæ of *Anobium striatum*," a European household beetle (Thesaurus, etc., p. 138), and from worm-eaten ash infested with *Hylesinus fraxini* (Entomologist, l. c.). From the description and the hosts given it is evidently a distinct species.

Since the above was written the same species was recognized in a lot of sweet-pea seeds from Philadelphia, Pa., infested with the drug-store beetle, *Sitodrepa panicea*. As this was the only beetle living in these seeds at the time, there is no doubt whatever that this Cerocephala is a parasite of it. It is equally certain that this parasite has already been introduced in this country. It may be noted here that the *Pteromalus calandræ* of Howard is known to prey upon both Calandra and Sitodrepa.